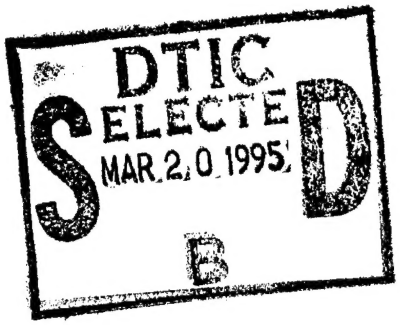

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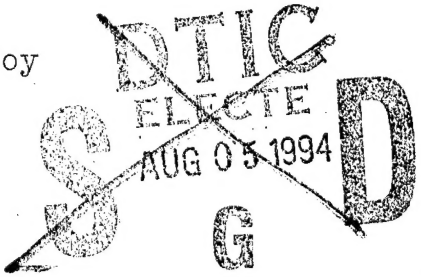
CONFERENCE ON PROBLEMS OF DEVELOPMENT OF DEEP SEISMIC SOUNDING OF THE EARTH'S CRUST

By K. A. Kosovskiy and V. Z. Ryaboy



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CONFERENCE ON PROBLEMS OF DEVELOPMENT OF DEEP SEISMIC SOUNDING OF THE EARTH'S CRUST

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The results of the latest geolocial investigations have shown that to organize scientifically-based prospecting for mineral deposits, the study of the structure of merely the blanket of sedimentary rocks is insufficinet. The acquisition of information concerning the nature of occurrence and the inner structure of the crystalline mantle of the earth's crust makes it possible to approach the solution of problems on the nature of regional gravitational anomalies as well as problems of the tectonic regioning of territories, the study of orogenic processes and problems related to the formation and migration of petroleum, metallogeny, etc. The most detailed information concerning the structure of the earth's crust can be obtained by the method of deep seismic sounding (DSS) of the earth's crust, proposed in 1958 by Academician G. A. Gamburtsev and developed under his direct guidance in the Institute of Physics of the Earth of the Academy of Sciences USSR from 1948 to 1955.

At a conference on problems of development of the deep seismic sounding of the earth's crust held in Moscow from

14 to 19 November 1960 results were cited and generalized of the more than 10 years of development of the DSS methods in the USSR. The conference was convened by the Institute of Physics of the Earth of the Academy of Sciences USSR, the Council of Prospecting Geophysics under the Presidium of the Academy of Sciences USSR, the Geophysical Department and the All-Union Scientific Research Institute of Geophysical Methods of Prospecting of the Ministry of Geology and Conservation of Mineral Resources USSR. Participating in the activity of the conference were 190 representatives of 40 organizations and institutions, twelve of which had conducted DSS work. The conference heard and discussed approximately 40 reports and communications. Participating in the work of the conference were the following very prominent geologists and geophysicists of the country, concerned with problems of the study of the subsurface structure of the earth's crust: V. V. Belousov, Yu. N. Godin, Yu. V. Riznichenko, B. A. Petrushevskiy, V. V. Fedynskiy, R. M. Demenitskaya, I. P. Kosminskaya, etc.

The following principal problems were examined at the conference:

1. DSS methods. Analysis and generalization of the features of subsurface waves recorded during DSS observations on land and sea;

2. The geological effectiveness of DSS methods and their combination with other geophysical methods of investigating the subsurface structure of the earth's crust;

3. New research on equipment and methods development.

The principal attention was devoted to examining problems related to the study and analysis of the wave picture recorded during DSS investigations. These problems were the subject of the overwhelming majority of the reports and communications (by Ye. I. Gal'perin, P. S. Veytsman, I. P. Kosminskaya, I. S. Vol'vovskiy, I. V. Pomerantseva, A. V. Yegorin, A. S. Alekseyev, I. V. Litvinenko, A. A. Popov, etc.). It was pointed out that during the last 10 years a consider-

able volume of DSS work was carried out on land and sea in the USSR. Beginning with 1956 the DSS work has been carried out in considerable volume by scientific research and production organizations in many regions such as in the areas of ancient and new platforms (Karelia, Volga-Ural region, Turkmenia, Kazakhstan), intermontane and piedmont troughs (Fergana, West Turkmenia), folded areas (Tyan'-Shan' / Tien Shan /, Pamir), inland seas (Black Sea, Caspian Sea), and in the transition zone between the continent and the ocean (northern coast and surface water area of the Sea of Okhotsk, the Kurile Islands arc, and adjacent sectors of the Pacific).

A majority of the speakers noted that the interpretation of the recorded wave picutre, based upon the assumption of the predominant intensity of the head-waves at considerable distances from the blast point, did not coincide with recent results of theoretical and experimental research in the field of the kinematics and, especially, the dynamics of seismic waves. This research showed that reflected supercritical / zakriticheskiye / waves predominate in intensity in the case of homogeneously stratified models of the earth's crust, whereas reflected supercritical waves and refracted (both one-time and repeated) waves, in the presence of vertical velocity gradients, predominate in the case of the non-homogeneously stratified models. Although at present there still exist many unclarities and conflicting opinions concerning the interpretation of the wave recorded pictures and the possible structure of the earth's crust, one thing is clear, that classical notions concerning the homogeneously stratified structure of the earth's crust are now being replaced by new ideas concerning the more complex structure of the latter. Of great promise for the ultimate solution of these problems is the broad utilization of the dynamic characteristics of waves, which are more sensitive than the kinematic characteristics to peculiarities of the structure of the earth's crust.

The DSS work carried out in various regions resulted in establishing the great diversity in the structure of the earth's crust, which on the whole is everywhere a non-homog-

enous medium slightly differentiated in velocities. Standing out most distinctly in this crust are two seismic boundaries related to the roof and foot of the crystalline bed of the earth's crust: the surface of the crystalline foundation and the surface of the subcrustal layer (Mohorovicic boundary).

A number of reports and communications (by V. V. Belousov, Yu. N. Godin. B. A. Petrushevskiy, V. V. Fedynskiy, B. B. Tal'virskiy, etc.) was devoted to the geologic effectiveness of DSS investigations. The study of the general problem of the processes occuring in the earth's crust should consist on the one hand, of ascertaining the differences existing in the subsurface structure of various regions and, on the other, of establishing the historical interrelationships between subsurface regions having varied structures. These problems should be solved by the combined application of geophysics and geology. The geophysical methods should reveal the regions with differing structure in the lower layers of the earth's crust, while geology (or more precisely, tectonic geology) should establish the nature of the historical interrelationships of these regions and the stages of development of the planet to which they correspond. The accuracy of DSS methods make it possible at present to study the peculiarities of the structure of fundamentally different regions, such as continents and oceans, platforms and geosynclines. In this connection DSS profiles should intersect large tectonic elements and regions having fundamentally different geologic structures. Of considerable interest is the problem of the geological nature of the "granite" and "basalt" layers of the earth's crust, isolated during interpretation of DSS data. Certain participants of the conference (Yu. N. Godin and I. A. Rezakov) expressed the interesting hypothesis that these layers might be composed of sedimentary rocks which were strongly metamorphized and reworked by the action of temperature and pressure, in the physical, rathern than geological sense characterizing the change in the phase state of matter. At present, however, there exist no reliable factual data corroborating or refuting this hypothesis.

The problems of combining DSS research with the data of gravimetry and seismology were broached in the addresses of Yu. N. Godin. V. V. Fedynskiy, S. I. Subbotin, V. I. Shraybman, R. M. Demeneitskaya, and others, who showed that the efficient combining of DSS with gravimetry and seismology made it possible to reduce the volume of expensive DSS operations and to lower the cost of geophysical studies of the subsurface structure of the earth's crust considerably. The combining of DSS materials with gravimetric data also makes it possible to draw very valuable conclusions on the nature of the gravitational field and to obtain conclusions on the nature of the gravitational field and to obtain additional information concerning the subsurface structure of the earth's crust. For example, it was shown that in certain regions the regional background of the gravitational field is very appreciably affected by the density anisotropy of subcrustal matter (reports of S. I. Subbotin and V. I. Shraybman). In connection with this the problem of increasing the depth of DSS investigations to 100 kilometers and beyond was posed.

A new trend in DSS research is the development of methods of field observations based upon the recording of reflected subsurface waves in the vicinity of blast point reports of I. S. Vol'vovskiy, Ye. D. Tagay, and N. P. Ivanova). The use of precritical reflected waves in DSS will make it possible to reduce the cost and improve the accuracy of the studies considerably. In solving this task satisfactory results are furnished by the use of the controlled directional reception (CDR) of seismic waves in field or laboratory modfications (report of V. Z. Ryabyy and G. G. Shteynberg). By means of CDR a large number of extremely important problems may also be solved, such as the isolation of the points of origin of head waves, the quantitative interpretation of zones of tectonic disturbances, subsurface ridges, etc.

At the conference reports were delivered on new studies in the field of DSS instrument building. Equipment of this kind includes a low-frequency highly sensitive seismic station (report of A. N. Mozzhenko); a seismic radio station

making it possible to dispense with wire communications during the conduct of field operations (report of S. I. Ivanov), equipment using the accumulation method, making it possible to heighten the effective sensitivity of the seismic channel sharply (report of V. S. Voyutskiy), etc. However, as noted in the speeches of the conference's participants, the introduction of new models of equipment lagged seriously behind the needs of DSS studies. Actually, the equipment being used at the present time has undergone no essential changes during the past 10 years. All this slows down the further development of DSS investigations. At the conference concrete paths of rectifying these shortcomings were outlined.

The resolutions of the conference noted the great theoretical and practical importance of DSS research and pointed to the need for closer contact between geophysicists and geologists with regard to the geological interpretation of DSS results. The conference recommended the establishment, under the Ministry of Geology and Conservation of Mineral Resources USSR, of an interdepartmental commission for the planning and coordination of DSS operations.

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1386